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Preface

This master's thesis, constituting thirty credits on the master's degree in Industrial Economics at the University of Stavanger, was conducted during the spring of 2023. Throughout this period, I have had the privilege of collaborating with several contributors who have had a significant impact on the completion of this thesis. I am grateful for the invaluable assistance I have received, which has been essential in the successful completion of this thesis.

I would like to express my sincere appreciation to my supervisor at the University of Stavanger, Ruth Pincinato, for her invaluable guidance and continuous motivation during the spring semester. I am also grateful to my co-supervisor, Anders Müller, for providing an excellent proposal for the thesis and for assisting me in finding interviewees for the thesis. Their support and insights have been indispensable in shaping the focus and direction of this thesis. Additionally, I would like to extend my gratitude to the interviewees who generously shared their knowledge and experiences during the thesis research. Their contributions have provided valuable information and insights that have enriched this work.

Mia Emilie Eidsvåg

Oslo, 11th of July 2023

Abstract

This thesis examines the key factors related to success with innovation test facilities and explores how effective collaboration can drive societal development in a given region. The thesis emphasizes the need for organizations to create and implement new solutions and engage in innovation to address the current global challenges faced by society and the environment. The initial part of the thesis introduces the methodology employed in the study, followed by a theoretical section that elucidates central concepts and outlines the four types of test facilities considered in this research.

Subsequently, the thesis presents the discussion and findings derived from interviews conducted for this study. The results section is structured according to the research question, with the first part focusing on the key factors identified by the interviewees that contribute to the success of innovation test facilities. This includes the importance of demand, well-established infrastructure, competent facilitators, financial support, and a positive mind towards learning from mistakes. Moreover, the importance of building robust connections and promoting collaboration among stakeholders is emphasized as crucial for achieving success.

The second part of the results and discussion elaborates on the insights obtained from the interviews regarding how effective collaboration both external and internal can act as a catalyst to enhance innovation capabilities and foster societal development within a specific region. It emphasizes the need to inform the government about the benefits of test facilities, collaborate with supply chain companies, share information within smart cities, and implement effective follow-up methods in innovation clusters. Furthermore, adopting a long-term perspective and prioritizing collaboration with major actors like the European Union are crucial for national development and increased value creation in regions. Overall, this thesis provides insights into the key factors that contribute to the success of test facilities and effective collaboration in driving innovation and societal development in a region.

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1. Introduction

To solve today's societal and climate challenges all over the world, organizations need to develop and launch new solutions and engage in innovation. Business leaders must constantly look for new ways to innovate because you cannot solve many new problems with old solutions (Boyles, 2022). Innovation allows adaptability, it fosters growth, and it separates businesses from their competition (Boyles, 2022). As an answer to why we need innovation in an economic term, it can be said that innovation can lead to higher productivity, meaning that the same input generates a greater output. As productivity rises, more goods and services are produced – in other words, the economy grows (Bank, 2017). To develop and launch new solutions to societal challenges, companies and organizations need opportunities and access to an environment where new ideas and technologies can be tested in complex and realistic environments. Prior research has shown that innovation test facilities play important roles in technological innovation developments to make them commercial (Hans Hellsmark, 2016). You can see these test facilities as innovation test arenas to find the answers to whether the ideas are worth developing further, or whether one should simply scrap the plans for further development. Studies have shown that moving a novel technology from the lab to the living room consists of a complex co-evolving process among technology, regulations, infrastructure, and consumer behavior (Stelvia Matos, 2022).

By different professional environments, organizations, the public sector, and research institutions collaborating to carry out development projects in joint test arenas, new partnerships and possible increased innovation will be created. Organizations and cities worldwide can benefit from these innovation test facilities. The UN's Sustainable Development Goal number 17 is "cooperation to achieve the goals» and is about strengthening the means needed to carry out the work and renewing global partnerships for sustainable development (Norway, Samarbeid for å nå målene, 2023). The authorities, business and civil society must work together to achieve sustainable development (Norway, Samarbeid for å nå målene, 2023).

In the realm of regional development, innovation test facilities hold great potential in offering valuable insights and aiding in the transformation of ideas into tangible solutions. Over the past few decades, there has been an increasing recognition that national innovation policies need to be complemented by regional innovation policies (Cai Yuzhuo, 2018). These regional innovation policies are specifically designed to foster development based on the unique capabilities, characteristics, and needs of local industries (Cai Yuzhuo, 2018). Each region

possesses distinct opportunities and available resources for further development. The establishment of test facilities in these regions can pave the way for long-term innovation opportunities and contribute to economic growth. By establishing such a framework, innovation test facilities can strengthen their role in driving regional development and facilitating enduring solutions.

1.1 Scope

The field of innovation test facilities has gained significant attention in recent years, also in Norway and the Nordic region. Various publications and research studies have already explored the mapping of test facilities in Norway and the Nordic region, through among others Menon and the Nordic Council of Ministers, and those are offering valuable quantitative insights (Leo A. Grünfeld, 2016) (Ministers, 2018). However, this thesis takes a different approach by delving into the qualitative information provided by organizations actively involved in test facilities. By examining the perspectives of four case organizations, this study provides insights on their perceptions with regards to success factors of test facilities and how they effectively collaborate around their innovation test facilities to address societal challenges in their respective regions.

To achieve this goal, the case organizations have been carefully selected to represent different aspects of the innovation test facility landscape. These case organizations encompass a smart city initiative, a physical test arena, a smart city cluster and an organization responsible for coordinating multiple test facilities on behalf of the government. By analyzing the answers from interviewees from these diverse organizations, we can gain deeper insights into the strategies employed by these organizations to maximize the impact of their test facilities on society, which again can help strengthen business and the regions willingness to finance further investment in test facilities.

It is important to note that the scope of this thesis focuses on the perspectives of the case organizations. This thesis will not have a focus on the financial gain of the test facilities but rather focus on what the case organizations see as success factors for test facilities and how to carry out collaboration to contribute to increased innovation power for the region and nationally in the long term.

1.2 Research question

The main aim of this thesis is to shed light on which factors the different case organizations highlight from their point of view as central to running their innovation test facilities as well

as possible to contribute to finding solutions to societal challenges in their region. This also with focus on the necessary collaboration both external and internal to make their innovation test facilities help to find these new solutions. This results in the following research question for the thesis:

"What are seen as the key factors associated with successful innovation test facilities in diverse contexts, and how can effective collaboration serve as a catalyst to enhance innovation capabilities and foster societal development within a given region?"

The revised research question seeks to explore the key factors that contribute to the success of test facilities in various contexts. Test facilities play a vital role in conducting experiments, trials, and assessments to validate and improve products, technologies, or processes. By identifying the factors that contribute to their success, this research aims to provide valuable insights into the elements that organizations or regions should focus on to optimize the effectiveness and impact of their test facilities.

Additionally, the research question investigates the role of collaboration in driving innovation and contributing to societal development within a specific region. Collaboration involves cooperation and knowledge-sharing among stakeholders such as industry, academia, government, and community organizations. By examining the relationship between collaboration and innovation, the research seeks to understand how collaborative efforts can enhance the innovation capacity of test facilities, leading to advancements that positively impact society.

Overall, this thesis examines the key factors related to success with innovation test facilities and explores how effective collaboration can drive societal development in a given region.

1.3 Chapter overview

The initial chapter of this thesis will introduce the methodology employed in the study. It will elaborate on the rationale behind the selection of qualitative interviews as the chosen method and discuss the foundational literature used as a framework. Additionally, the chapter will provide insights into the four interviewees and their respective organizations, referred to as case organizations throughout the thesis.

The second chapter will delve into the theoretical foundations that underpin the study. It will begin by providing a comprehensive explanation of central concepts, followed by an exploration of the four types of innovation test facilities that hold relevance to the thesis.

Moreover, the chapter will introduce regional development with a specific emphasis on fostering innovation. Lastly, a detailed report mapping innovation test facilities in Norway will be presented, focusing on the criteria for measuring their success in facilitating innovation and collaboration.

The third chapter of this thesis encompasses the presentation and discussion of the results. The chapter is divided into two parts, as a result of how the research question is structured. In the first part, the focus lies on the results derived from interviews, specifically examining the key factors that contribute to the success of innovation test facilities. Here, the seven identified points pertaining to the success criteria for test facilities will be presented and thoroughly discussed. The second part of the chapter explores the theme of collaboration and how test facilities can enhance their collaborative efforts with a specific emphasis on fostering innovation. This section initially presents the results obtained from interviews, highlighting critical aspects of collaboration related to innovation test facilities. Subsequently, the various collaboration agencies are examined and discussed based on the insights gathered from the conducted interviews.

Lastly, the thesis concludes by presenting a succinct summary of the obtained findings and their implications through a dedicated conclusion section. This section highlights the key insights derived from the results and discussions, effectively addressing the research question. Furthermore, the conclusion acknowledges the limitations inherent in the thesis and suggests potential avenues for future research. These suggestions aim to broaden and enrich the existing knowledge within the field, encouraging further exploration and advancement.

2. Methodology

This chapter provides an overview of the applied methodology employed for conducting research and gathering relevant data for this master thesis. The methodology encompasses three key components: a literature study, four qualitative interviews, and the selection of the four case organizations that are central to this thesis.

2.1 Literature study

To gather existing research articles and current literature on the topic, Google Scholar was utilized as a primary source. This was useful during the search for literature to obtain information with high quality and to gain insight into current theory. To streamline the search on Google Scholar, specific keywords were employed to identify relevant literature. These keywords encompassed areas such as “innovation as a catalyst for regional development,” “smart city innovation”, “cluster innovation”, and “collaboration in innovation”.

The search revealed a considerable number of articles discussing innovation, although it proved challenging to locate directly relevant articles pertaining to test facilities. This difficulty may arise from the varied terminologies used to refer to such facilities. Therefore, in the search process, terms like "living labs," "test arenas," "test facilities," and "test labs" were applied interchangeably to ensure comprehensive coverage of the subject matter. To determine the relevance of the articles being reviewed, a systematic approach was adopted. Initially, the abstract, introduction, and conclusion sections of each article were examined to gain a preliminary understanding of the article's content and focus. This initial screening process helped to identify whether the article aligned with the research topic at hand. If the article appeared relevant based on this initial assessment, further reading was applied by delving into the substantive content of the text for a more comprehensive evaluation.

The student thesis database at the University of Stavanger served as a valuable resource for exploring other master's theses. The objective was to identify if any other theses shared the same topic as this thesis and to determine the presence of relevant existing material on the subject. The analysis revealed numerous tasks already existing on the subject of innovation, yet there were scarcely any directly associated with innovation test facilities.

Additionally, relevant literature from the European Union (EU) was considered. These articles were deemed to possess a high level of reliability, and they provided valuable definitions related to the research topic. Furthermore, studies conducted within Norway yielded insightful

reports on the subject. Notably, two survey reports focused on test facilities, one conducted within Norway and another encompassing the Nordic region.

Menon Economics conducted a comprehensive survey on behalf of the Ministry of Trade and Fisheries, specifically examining infrastructure for testing, piloting, visualization, and simulation in Norway. This report offers extensive information regarding Norway's test facilities and their definitions, providing valuable insights. Furthermore, the Nordic Council of Ministers' report on the mapping of test and demonstration facilities in the Nordic region identifies their geographical locations and references ten exemplary projects that serve as best practices for test facilities. The report also highlights success factors associated with test facilities. Some of the key points from these reports will be highlighted later in the theory part of this thesis.

2.2 Interview

The initial phase of this thesis involved conducting literature studies, which served as a foundation for formulating thoughtful and insightful questions in the interview guide. Qualitative method is used as interview method in this thesis. It is used to collect information by examining the opinions and experiences of the people who experience the topic in question (Dalland, 2017, s. 52). Since this thesis is about gathering experiences from key people and key case organizations and then work this information further, the method will give more specific answers than when using a quantitative method, which you can use when you need to provide data in the form of measurable units, which should, for example, be used in arithmetic operations and the like (Dalland, 2017, s. 52). To answer the research question, the intention is to use experiences and expertise from the four case organizations in this thesis.

The purpose of conducting qualitative interviews was to acquire a comprehensive understanding of the interviewees' perspectives and gather as much information as possible. By utilizing open-ended questions, the interviewees have the chance to provide detailed and supplementary responses, and it is possible to extract a wealth of information from their experiences in relation to the research questions. In the context of the study, the individuals being interviewed, considered as knowledgeable sources providing valuable information, are referred to as interviewees (Dalland, 2017, s. 65).

To establish a coherent structure throughout the interviews, the interview guide was organized into four key themes that directly addressed the problem at hand in this thesis. These themes included the introduction, success factors for innovation test centers, collaboration, and future

prospects. As the thesis progressed, it became apparent that the introduction and future aspects of the interviews naturally intertwined with the success factors and collaboration themes. Consequently, these themes were merged for a more streamlined approach. The interview guide was shared with the interviewees approximately one week prior to the scheduled interviews, affording them time to prepare thoughtful and informed responses.

The interviews were conducted digitally via Teams since some of the interviewees work and live in countries outside of Norway. Follow-up questions beyond the interview guide were asked, to confirm whether the information given was understood correctly. In a qualitative interview, you also want to elicit a nuanced description of the situation the interviewee is in. Follow-up questions will therefore provide more comprehensive descriptions (Dalland, 2017, s. 68). The interview was sound recorded, with the consent of the interviewees. The information given in the interview could therefore be analyzed afterwards, and the risk of missing relevant, important information was reduced. The recordings were deleted after the agreed time with the interviewees.

Following the completion of the interviews, the next step involved transcribing each of the four interviews directly after conducting the interviews. This transcription process was crucial for extracting significant information that could be utilized in the thesis. Key aspects and noteworthy findings from the interviews were identified and examined. By comparing these findings across the interviews, a foundation was established for the subsequent discussion within the thesis.

2.2.1 Interviewees

The selection of interview subjects was based on their existing contact with the co-supervisor of this thesis, resulting from previous collaborations with three individuals working in the case organizations. This prior knowledge ensured that these individuals possessed relevant information and might be interested in participating in the interviews. All interviews were conducted between March and May in spring 2023. Given their significant positions within their respective organizations, the interviewees were considered to provide valuable insights for this thesis. Consequently, it was not considered necessary to interview multiple individuals from the same organization. To prioritize the case organizations over individual interview subjects, their names are not mentioned in this thesis, aiming to redirect attention towards the organizations in which these individuals are employed.

The organizations participating in this study exhibit unique approaches and fulfill diverse roles within their respective organizations regarding test facilities. Despite their individual distinctions, they all possess experience and expertise in the realm of innovation test facilities. Additionally, to gain a contrasting perspective on the topic, later on in the thesis writing, an interview was conducted with a representative from an organization responsible for coordinating test facilities on behalf of the government. This organization's role differed from the other case organizations, as it is more involved in the coordination aspect rather than direct testing. Conducting this additional interview, later in the writing process, proved to be highly valuable, providing a distinct and contrasting viewpoint that enhanced the thesis.

2.3 Case organizations

This thesis focuses on four distinct case organizations: Copenhagen Solution Lab, European Marine Center (EMEC), Nordic Edge, and SIVA. These organizations differ from one another and embody various approaches to working with innovation test facilities. Copenhagen Solution Lab is a smart city initiative primarily dedicated to addressing challenges within the city of Copenhagen. It represents the Smart City initiative perspective in this thesis, focusing on problem-solving within an urban context. EMEC serves as a specialized test arena where external companies can utilize their facilities to practice innovation and develop their products. It represents the physical test arena perspective, providing a platform for companies to test and refine their innovations. Nordic Edge operates as a cluster for companies across multiple sectors, all sharing a focus on innovation and Smart City initiatives. It represents the cluster perspective, fostering collaboration and innovation within a regional context. Nordic Edge shares a similar perspective to Copenhagen Solution Lab as a Smart City in terms of their focus on developing smart city technology. However, there is a distinction in their operational approach. Copenhagen Solution Lab primarily works on behalf of the government, whereas Nordic Edge primarily aims to promote and develop innovative solutions for its cluster members. In this thesis, Nordic Edge is viewed from a cluster perspective. On the other hand, SIVA distinguishes itself from the other three organizations by coordinating the process of offering test facilities to partners on behalf of the government of Norway. They represent the government perspective, working at a national level throughout Norway. While the first three case organizations primarily concentrate on developing their respective regions through innovation, SIVA operates on a national scale, coordinating innovation efforts across all of Norway.

2.3.1 Copenhagen Solution Lab

Copenhagen Solution Lab is a Copenhagen municipality organization dedicated to the development of the city through the testing and implementation of intelligent and data-driven solutions (Lab, Who are we?, u.d.). Operating under the Climate and Urban Development division within the Engineering and Environmental Department, they have a team of six employees. Their collaborative approach involves working with the research community and the market to generate innovative solutions for the municipality. Projects at Copenhagen Solutions Lab span various areas, including energy optimization of buildings through artificial intelligence and initiatives focused on addressing air pollution in Copenhagen (Lab, Who are we?, u.d.).

The organization's website emphasizes the importance of dialogue between the city and external stakeholders in generating the best solutions (Lab, Who are we?, u.d.). By leveraging collaborations with the research community and the market, Copenhagen Municipality gains access to the necessary innovative power, knowledge, and technology to create effective urban solutions. These solutions are subsequently implemented in the municipality's operations and development.

With a population of approximately 1.3 million people in 2017 (Phil, 2021), Copenhagen faces challenges related to air pollution and other externalities common in big cities. Copenhagen Solution Lab addresses these issues through projects such as energy optimization of buildings using artificial intelligence, the establishment of new air measurement stations, and street-by-street mapping of air pollution in the city (Lab, Cases, u.d.). Drawing on data provided by Copenhagen Solution Lab on air pollution, specific urban planning guidelines are developed to tackle these problems and improve the city's environmental conditions.

2.3.2 EMEC

Established in 2003, the European Marine Energy Center (EMEC) is a pioneering facility dedicated to the testing and demonstration of wave and tidal energy converters (Centre T. E., About Us, n.d.). There are over 88 employees in EMEC (Centre, About Us, n.d.). Situated in the Orkney Islands, located in the north of Scotland, EMEC also focuses on developing a green hydrogen economy and smart local energy systems. They provide purpose-built open-sea testing facilities for prototype technologies (Centre T. E., About Us, n.d.).

EMEC's mission, as stated on their website, is to serve as an innovation catalyst by expanding their expertise, services, and infrastructure to accelerate the progress of sustainable

technologies to market while reducing time, cost, and risks (Centre T. E., About Us, n.d.). As a specific test arena, EMEC hosts companies seeking to practice innovation and develop their products using the facility's resources.

In spring 2023, EMEC published a report on their website highlighting their impact on the Orkney region and the UK economy. The report highlights EMEC's significant influence on employment, supply chain development, and the attraction of public and private investments to support the sector (Center, 2023). An independent economic audit conducted by Biggar Economics assessed the value and benefits of EMEC's activities from 2003 to 2023, considering both local and national impacts. The analysis encompasses EMEC's operations across the entire value chain, including site construction, operation, and demonstration activities. The economic impact assessment reveals that EMEC has contributed £370 million in gross value added (GVA) to the UK economy, with £263 million accrued in Scotland and £130 million specifically in the Orkney Islands, where EMEC is headquartered (Center, 2023).

Overall, EMEC plays a pivotal role in advancing marine energy technologies, promoting economic growth, and making significant contributions to the Orkney Islands and the UK.

2.3.3 Nordic Edge

Nordic Edge is a non-profit organization that collaborates closely with private companies, municipalities, academia, and citizens to advance smarter and more sustainable cities and communities (Edge, Advancing a smarter and greener Tomorrow, u.d.). With a team of ten employees, Nordic Edge serves as a cluster, bringing together a diverse member base consisting of private companies, public sectors, academia, and finance institutions. Their collective goal is to collaborate in the development, scaling, and exportation of solutions for creating better cities (Edge, About, u.d.). Nordic Edge operates from their coworking space, Innoasis, located in Stavanger.

As a cluster for companies across various sectors, Nordic Edge fosters innovation and serves as a driving force on behalf of its members (Edge, About, u.d.). They initiate and facilitate partnerships to secure financing for innovation, support pilot projects and testing, foster cooperation among members, and create and strengthen commercial opportunities (Edge, About, u.d.). Through these collaborative efforts, Nordic Edge strives to accelerate the development and implementation of innovative solutions that address the challenges faced by cities and communities (Edge, About, u.d.).

Nordic Edge's mission is to function as a catalyst for positive change, leveraging their network and resources to drive sustainable urban development and improve the quality of life for citizens (Edge, About, u.d.). By promoting cross-sector collaboration and facilitating knowledge exchange, Nordic Edge plays a vital role in shaping the future of smarter and greener cities.

2.3.4 SIVA

SIVA, established in 1968, is a state enterprise that plays a role in developing, owning, and financing a national infrastructure for innovation and business development (SIVA, Om Siva, u.d.). This infrastructure encompasses a wide range of entities such as incubators, business parks, catapult centers, innovation companies and innovation centers (SIVA, Om Siva, u.d.). SIVA operates within the business-oriented policy apparatus and has a specific focus on promoting growth in rural areas. With over 9,000 companies being part of SIVA's infrastructure, they provide essential support to foster innovation and business growth in Norway (SIVA, Om Siva, u.d.).

While the previous three case organizations primarily focus on regional initiatives, the final case organization has a different role. SIVA coordinate the process of connecting companies that offer test facilities to partners and operate at a national level. The catapult centers, under SIVA's coordination, have been instrumental in carrying out approximately 800 projects related to the Norwegian environment in 2020 (SIVA, Norsk Katapult). They have received substantial public support, with 156.4 million NOK invested in equipment and additional funding allocated for competence and service development (SIVA, Norsk Katapult). The catapult centers offer companies access to equipment and test facilities valued at an estimated total of 1.6 billion NOK, representing a significant investment in accelerating innovation through public support (SIVA, Norsk Katapult).

By facilitating partnerships and providing access to state-of-the-art equipment, the coordination efforts of SIVA and the catapult centers contribute to the advancement of innovation and business development in Norway. Their work strengthens the collaboration between public institutions, research organizations, and companies, reinforcing the national innovation ecosystem and enabling companies to benefit from valuable resources and support (SIVA, Norsk Katapult).

The case organizations play a significant role in promoting innovation and business development through their distinctive approaches to working with innovation test facilities.

They do not only address regional and national challenges but also foster collaboration and knowledge exchange within their respective domains (SIVA, Norsk Katapult). In addition to their contributions, the theoretical part of this thesis will delve deeper into the role of the case organizations in development and innovation, as well as explore other central concepts relevant to innovation test facilities. This comprehensive exploration will provide a more nuanced understanding of the organizations' impact and shed light on their unique practices and strategies.

3. Theory

This chapter will begin by providing an overview of essential concepts related to the thesis. Subsequently, the four types of innovation test facilities pertinent to the thesis will be presented. Following this, regional development will be explored with an emphasis on innovation, as well as the role of collaboration in fostering innovation. Lastly, a comprehensive report mapping innovation test facilities in Norway will be reviewed with focus on success factors for innovation test facilities.

3.1 Central concepts

Innovation by definition is a new or significantly changed product, service, production method, way of organizing or marketing activities, which has been put into use (Ørstavik F. , 2023). There are an infinite number of ways to engage in innovation, whether the result is a new product called product innovation, or for example something more abstract, such as a service or a new combination of product and service (Ørstavik F. , 2023). You can say that without innovation, there is not anything new, and without anything new, there will be no progress (Kylliäinen, 2019). Europe's economic prospects depend on innovation in general, and especially digital and new frontier technologies, including artificial intelligence, Internet of Things, blockchain, high-power computing, and the integration of biology and engineering (Jacques Bughin, 2019). These technologies have the potential to deliver the breakthrough in productivity that Europe needs (Jacques Bughin, 2019). You can say that the innovation is successful when it has gained the ability to provide distinct value to the customer as a third party while generating revenue for its developers (More, 2011).

Testing and experimenting state-of-the art software and hardware solutions and products in real-world environments, and at scale, is an important step to bring innovative technology to market (Comission, Testing and Experimentation Facilities (TEFs): Questions and answers, u.d.). Facilities are defines as buildings, pieces of equipment, or services that are provided for a particular purpose, and testing is defined as the activity of testing something or someone in order to find out information (Dictionary C. , u.d.). In this thesis, both the physical test arenas and the initiatives that foster innovation through implementing ideas and physical objects are seen under the definition of innovation test facilities. At such test facilities, new ideas and technologies can be tested in complex and realistic environments, and the customer often helps gain experience before the product is possible scaled up (Comission, Testing and Experimentation Facilities (TEFs): Questions and answers, u.d.). Infrastructure for testing can be shared between companies, since the facilities often require large investments that do not

pay off internally for the company over a long period of time. Many different terminologies are used for these facilities, such as test arenas, living labs and innovation hubs, but in this thesis, they will be mentioned as innovation test facilities.

The EU has a way of explaining the different layers of test facilities, which they themselves refer to as testing and experimentation facilities (TEFs) (Comission, Testing and Experimentation Facilities (TEFs): Questions and answers, u.d.). To distinguish between the different layers of these TEFs, EU utilize the following terminology: A sectorial TEF, such as one for manufacturing, constitutes a consortium. A consortium represents a network comprising multiple nodes and, if applicable, smaller satellites. Each node delivers the designated services and possesses the necessary infrastructure for the testing. A satellite is a smaller testing facility compared to a node and can provide either physical or remote access.

3.2 Innovation test facilities in different forms

In the realm of innovation test facilities, various forms and types exist, each serving unique purposes and playing distinctive roles. Smart city initiatives represent one such form, focusing on solving urban challenges and driving innovation within city contexts. Clusters, on the other hand, bring together companies from different sectors, fostering collaboration and innovation within specific regions. Physical test arenas provide dedicated spaces where external companies can utilize facilities to practice innovation and develop their products. Another form, catapult centers, coordinate the process of offering test facilities on behalf of the government, supporting national-level innovation efforts. This section explores these different forms of innovation test facilities, highlighting their characteristics and contributions to fostering innovation and development in diverse contexts.

3.2.1 Smart City Initiatives

A smart city leverages information and communication technology to enhance operational efficiency, promote information sharing with the public, and deliver better government services and citizen welfare (Institute). Today, major cities face numerous challenges related to development, inclusivity, adequate housing, climate, infrastructure, and more (Hans Schaffers, 2012). With over half of the global population residing in urban areas, this percentage is projected to further increase. Consequently, the concept of smart cities has evolved to encompass environments that foster innovation, empower citizens, and encourage participation from businesses and other stakeholders in shaping their future through informed choices and decisions (Hans Schaffers, 2012). In many large cities, these complex ecosystems prioritize sustainable development and strive to enhance quality of life for their inhabitants

(Hans Schaffers, 2012). Smart cities aim to address the diverse needs of citizens, government entities, and businesses across various sectors, such as healthcare, energy, housing, and climate.

3.2.2 Cluster

The term "cluster" can be regarded as ambiguous, with various authors offering differing definitions on the subject (HAMDOUCH, 2008). A cluster refers to a concentration of innovative and active organizations within a particular region or state (Vladimir V Mazur, 2016). According to Michael Porter's conception in 1990, clusters are characterized by the proximity of actors and the presence of competitive and cooperative interactions among co-located firms (HAMDOUCH, 2008).

The literature highlights several key advantages of utilizing clusters. Firstly, clusters generate positive effects not only for the member organizations but also for the overall region. The intense competitive pressure within clusters fosters development and growth among member companies in comparison to similar enterprises outside the cluster (Vladimir V Mazur, 2016). Additionally, clusters possess a greater ability to coordinate efforts and financial resources, facilitating the creation and commercialization of new products and technologies (Vladimir V Mazur, 2016). Unlike traditional industrial settings, innovation clusters establish a system of close relationships not only among cluster members but also with knowledge institutions such as research centers, universities, and even government entities (Vladimir V Mazur, 2016).

3.2.3 Physical test arena

Physical test arenas for innovative technologies can be referred to using various terms in the literature, such as test and experimentation platforms, living labs, usability labs, demonstration centers, and test arenas (BALLON, 2005). In this thesis, the term "physical test arena" will be used to describe these facilities within the context of innovation test facilities.

The literature identifies three main rationales for establishing successful physical test arenas (BALLON, 2005). Firstly, there is a growing awareness among policymakers about the significance of innovation activities for enhancing competitiveness. Secondly, test arenas help address systemic failures in the innovation process by providing a supportive environment for experimentation and testing. Lastly, involving users in the innovation process is crucial for effective development and validation of new technologies.

It is noted that physical test arenas should be considered semi-mature in terms of their "distance to the market." Their primary focus should be on facilitating innovation activities

rather than fundamental research. To foster wider utilization in the market, test arenas should actively collaborate with various business stakeholders, building trust and creating opportunities for broader adoption (BALLON, 2005).

3.2.4 Catapult centers

Catapult centers, also referred to as catapults is represented from one of the case organizations, SIVA. The Catapult centers are working to make it easier for innovative companies to develop prototypes, test, visualize and simulate. This makes the path from the concept stage to market introduction easier for Norwegian industry. The Norwegian catapult was launched as one of nine priority measures when the Government Solberg in March 2017 presented the Industry Report "Industry - greener, smarter and more innovative". The ambition is to build an infrastructure for innovation with 7-9 national catapult centers in areas of great value for future industry in Norway. Siva manages the scheme on behalf of the Ministry of Trade and Fisheries, and in close cooperation with Innovation Norway and the Research Council. (SIVA, Om norsk katapult / About Norwegian Catapult, u.d.). Each catapult center must function as a consortium to be considered a catapult, and by that it means as mentioned earlier in the thesis, which is a network that is working with the same goal.

In this thesis, we examine the concept of catapult centers, also known as catapults, represented by one of the case organizations, SIVA. In this context, it is possible to view Nordic Edge as a catapult center, but since its SIVA who refer to and call their consortiums catapult centers, this is not a used term of Nordic Edge. Catapult centers play a crucial role in facilitating the development, testing, visualization, and simulation of prototypes for innovative companies (SIVA, Om norsk katapult / About Norwegian Catapult, u.d.). Their purpose is to streamline the journey from the conceptual stage to market introduction, making it easier for the Norwegian industry to bring new innovative ideas. To qualify as a catapult center, each consortium must function as a network working towards a common goal, as mentioned earlier in this thesis. This collaborative approach ensures that the catapult centers operate effectively and foster innovation in their respective domains.

3.3 Test facilities in regional development

In recent decades, there has been a growing realization that national innovation policies must be supplemented with regional innovation policies (Cai Yuzhuo, 2018). You can say that the regional innovation policies are specifically aimed at creating development based on the capabilities and characteristics and the needs of regional and local industries (Cai Yuzhuo, 2018). The regions vary in relation to what they have opportunities for and what resources

they have available to develop further. The utilization of experimentation and testing as a catalyst for innovation, learning, and knowledge creation in regions leads us to the realm of climate governance (Evans, 2014). Test facilities provide a valuable opportunity for cities or regions striving to transition to a low-carbon economy, enabling them to generate knowledge that can aid in reducing environmental impacts, resource consumption, and fostering economic growth (Evans, 2014). A significant implication of this approach to governance is the involvement of research organizations such as universities and government funding bodies, as they are increasingly drawn into the ecosystem of sustainable urban development to address knowledge and financial gaps (Evans, 2014).

According to a report highlighting regional growth within the European Union, technology, technological progress, and human capital are identified as the driving forces behind the sustained improvement of living standards (Rodriguez, 2011). By incorporating innovation efforts as a factor influencing growth in a region, the theoretical perspective accommodates for persistent disparities in growth rates among regions. It can be argued that regions that possess abundant knowledge and human capital enjoy a continuous advantage over less-endowed regions that rely on externally embedded technology, as they lack the capacity to generate their own advancements. The capacity to innovate and to assimilate innovation have regularly been considered as two of the key factors behind economic dynamism of any territory (Evans, 2014). The purpose of the test facilities are to allow the staging experiments that can be repeated dependably anywhere, transforming events into facts (Evans, 2014). This universal knowledge can purportedly be transferred to other places and applied easily and unproblematically if they share some similarities (Evans, 2014).

The Nordic Council of Ministers' report identifies several success factors associated with successful test facilities (Ministers, 2018). One key factor emphasized in the report is the availability of necessary infrastructure for testing, as it plays a vital role in conducting comprehensive and realistic tests of new products or ideas (Ministers, 2018). Another crucial aspect is access to expert staff who can provide guidance and support during testing, assisting companies in determining their next steps. The report also underscores the significance of combining different research areas or domains of expertise. By integrating diverse fields of research and industrial sectors, test facilities can enhance their chances of success. (Ministers, 2018).

Managing effective collaborations is highlighted as another critical success criterion for innovation test facilities (Ministers, 2018). Establishing and nurturing strong partnerships are

essential for facilitating testing and driving innovation. It is essential for partners involved in testing innovation at these facilities to maintain realistic expectations, as it is likely that not everything will go according to plan. This mindset can be challenging to implement but is crucial for fostering a constructive testing environment (Evans, 2014).

3.4 Collaboration in innovation

Collaboration is defined as the shared commitment of resources to the mutually agreed aims of several partners (Mark Dodgson, 2014). There is both internal collaboration, which is when individuals or groups within an organization work together and share knowledge, or external collaboration which means sharing knowledge or working with individuals outside the organization (Team I. E., 2022). Innovation invariably involves many and diverse contributors, and very few organizations today, if any, can innovate without collaborating in some form (Mark Dodgson, 2014). The literature mentions some benefits of collaborating on innovation. The first thing is that collaboration work best when there is mutual respect amongst peers in the various partners (Mark Dodgson, 2014). It can be important to highlight who are responsible for the management of the collaboration, and research shows that collaboration often need talented managers to encourage performance in partner organizations. Criteria for assessment and performance of the collaboration should be clearly identified, and the collaboration also should be capable of adapting to changing circumstances and opportunities (Mark Dodgson, 2014). When working with innovation, the managers need to be flexibility in the collaboration, as unforeseen obstacles or opportunities might emerge. The process of developing something new necessitates extensive testing, which inherently involves making mistakes along the way. Rather than fearing mistakes, it is crucial to ensure that they are not repeated. However, it is essential to approach this journey with an agile mindset, where failure does not become a disadvantage but rather an advantage (Kessler, u.d.).

To foster effective collaboration, it is essential to cultivate trust among all parties involved (North, u.d.). Establishing and sustaining mutual trust is a fundamental prerequisite for successful cooperation. Trust can be nurtured in a collaborative setting by ensuring the presence of four key elements: Competency, which involves carrying out tasks effectively; consistency, which entails consistently making the right choices over time; integrity, which involves consistently acting in an ethical manner; and compassion, which involves genuinely caring for others and making decisions that benefit them (Team, 2022). Irrespective of the

parties involved, these fundamental concepts hold great importance in any collaborative endeavor.

The concept of the Triple Helix refers to the interactions among the three principal institutional spheres in an economy: the university, industry, and government (Mohammes Saad, 2011). Making the Triple Helix system work effectively in developing countries and regions is seen as a policy challenge. Triple Helix collaborations, through the combination of expertise, assets, and resources, can facilitate technological advancements and efficient knowledge transfer.

Government plays a crucial role in promoting collaboration by providing support for various reasons, such as addressing concerns about diminishing international competitiveness, increasing resources dedicated to innovation in key sectors and technologies, and reducing duplication in limited investments (Mark Dodgson, 2014). While universities may rank low in the hierarchy of innovation sources for firms, many leading businesses recognize the value of collaborating with universities due to their different cultural perspectives and longer-term horizon in problem-solving (Mark Dodgson, 2014). Universities often engage in extensive research and consulting projects for businesses, further highlighting their potential for collaboration. There are several start-up companies in Norway that started at the universities on various lines of entrepreneurship or other lines that focus on innovation. Several of these start-ups have managed to obtain financial support so that they further can scale and contribute to increased innovation power in Norway (Norge, Disse gründermiljøene får ekstra midler, u.d.). For example, in 2020 support was given to, among others, the University of Oslo's start-up Nora, which focused on an innovation ecosystem for artificial intelligence (Norge, Disse gründermiljøene får ekstra midler, u.d.).

3.5 Innovation in Norway

The authorities in Norway have a goal of increasing innovation nationally. Public administration must be developed further - with good services to citizens and users, good use of society's resources and high trust. One way to achieve this is to increase innovation capacity, pace and scope (Regjeringen, 2020). Therefore, the government is strengthening work on innovation in the public sector. Their three main principles are about politicians and public authorities having to provide room for action and incentives to innovate, managers must develop a culture and competence for innovation, where one has the courage to think new things and learn from mistakes and successes and that public enterprises must seek new forms of cooperation (Regjeringen, 2020).

Innovation Norway is a special law company that receives annual grants from the state budget to trigger more innovation and value creation in Norwegian business. The company is owned by the Ministry of Trade and Fisheries and the county municipalities (Donald, u.d.).

Innovation Norway's task is to offer financing services, advisory and competence services, networking, and profiling services to the business world. The aim is that these funds are delivered in such a way that they trigger increased investment in innovation and internationalization, that they stimulate business to take risks and add additional capital, that something more happens than would otherwise have happened, and that it gives increased value creation.

Norwegian universities and colleges have an important responsibility for contributing to innovation in Norwegian businesses and in the public sector (høgskolerådet, u.d.). One of Norway's largest universities, NTNU, its research environments have a good and well-developed collaboration and partnership with business and the public sector regarding research training, student projects, exchange of knowledge and concrete expertise. NTNU's ecosystem for innovation and creation includes a wide range of actors and services. NTNU is a partner in several national cluster collaborations (NTNU, u.d.).

3.6 Innovation test facilities in Norway

In the Nordic countries and Norway, surveys have been made of where test facilities are located and what they can offer. The Nordic Council of Ministers' report on the mapping of test and demonstration facilities in the Nordics shows where they are located and what they do (Ministers, 2018). The report presents ten illustrative best practice cases. They indicate that a high degree of collaboration with the local surrounding eco-system and other partners who offer test and demonstration facilities is important to create added value for companies. They also believe that it may seem that collaboration in the Nordic countries may be rarer than in other countries.

Menon Economics has carried out a survey of infrastructure for testing, piloting, visualization, and simulation in Norway on behalf of the Ministry of Trade and Fisheries. They point out in terms of competitiveness for both business actors and public instrument actors that there is a need for access to physical infrastructure for carrying out this type of activities (Leo A. Grünfeld, 2016). The results from the report show that more than 60 percent of the facilities in Norway have spare capacity and of these, and that 85 percent are open to allow other actors to access the facilities. The report also indicates that there may be potential users of the facilities who do not currently make use of the opportunities, and that coordination and information

about existing infrastructure is lacking (Leo A. Grünfeld, 2016). The progress made by Norway can be seen as evidence of the distance covered, emphasizing the importance of collaboration, and sharing information to drive further advancements in development.

4. Results and discussion

In the preceding sections of the thesis, the methodology and theory chapters were presented individually, establishing the groundwork for addressing the research question. In this section of the thesis, the acquired results will be presented and analyzed in relation to the research question.

The upcoming chapter will present the findings and analysis derived from the interviews conducted for this thesis. It is divided into two sections, each addressing important aspects of the research and to answer the two-part research question of the thesis. Therefore, the first part focuses on the identified success criteria that emerged from the interviews, shedding light on the factors crucial for achieving success in utilizing innovation test facilities. The second part focuses on exploring optimal collaboration practices, highlighting strategies to maximize the utilization and effectiveness of these test facilities. Through this chapter, valuable insights will be provided to enhance understanding and guide future endeavors in the field of innovation test facilities to answer the research question.

4.1 Key factors for success with innovation test facilities

During the interviews, several key factors emerged as crucial factors for success with innovation test facilities. Measuring these success factors proved challenging in the interviews due to the evolving nature of innovation and the difficulty in quantifying its impact.

Government requirements and project quantity play a role in defining parameters. Non-profit organizations face obstacles in quantifying impact beyond financial success. The Smart City Cluster focuses on project quantity and qualification. EMEC conducts external surveys for evaluation, while SIVA primarily measures project numbers.

The first key factor highlighted for having success with innovation test facilities was having a strong demand for what the organization offers is essential to ensure the relevance and value of their services. Secondly, having proper infrastructure in place is vital to facilitate effective testing and experimentation. Thirdly, assembling a team of individuals with the right expertise and competence is necessary to drive innovation forward. Moreover, sufficient financial support is critical for sustaining operations, acquiring necessary resources, and fostering growth. Additionally, fostering a culture that embraces risk-taking and allows for failure is imperative to encourage innovation and learning. Lastly, creating strong connections and collaborations among different stakeholders and collaborators is key for knowledge sharing, resource pooling, and achieving collective success. By considering these key points,

organizations can enhance their success in operating innovation test facilities and contribute to significant advancements in their respective fields and contribute to developing the economics of the region. For an overview of the key factors highlighted in the interviews conducted for this thesis that will be explained, refer to Figure 4.1.

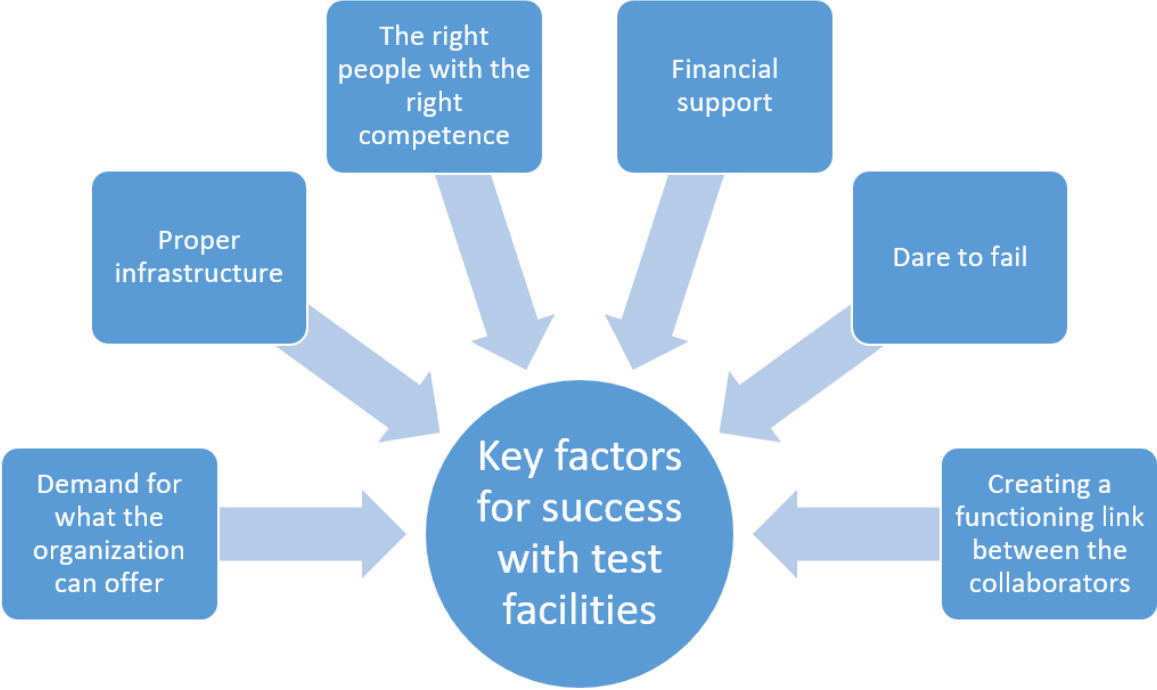


Figure 4.1: Key success factors for test facilities identified in thesis interviews

4.1.1 Demand for what the organization has to offer

To establish and operate successful testing facilities, it is essential to have a corresponding demand for the services and solutions offered by the organization. Working in the realm of innovation inherently entails an immature demand side, as the objective is to develop novel and groundbreaking ideas that may not be fully envisioned in advance. Conducting market research becomes advantageous in understanding the market's needs and identifying potential opportunities.

The organizations discussed in this thesis demonstrate a commitment to aligning their initiatives with market demand. They recognize the importance of responding to evolving needs and express intentions to expand their operations accordingly. For instance, Nordic Edge aims to establish an agriculture department, acknowledging the demand and potential opportunities in this sector. Similarly, EMEC is actively increasing its hydrogen and offshore wind facilities, indicating a strategic response to the market's growing interest and requirements in these areas. These organizations' initiative-taking approach to adapting and

expanding their offerings demonstrates their awareness of the significance of staying attuned to market dynamics and catering to emerging demands.

Furthermore, fostering effective collaboration and knowledge sharing with other operators of innovation test facilities can prove beneficial. By leveraging the collective expertise and experiences of industry needs, organizations can avoid duplicating efforts and enhance their capabilities. The importance of collaboration will be further explored in the second part of this thesis, which focuses specifically on collaborative practices within the context of innovation.

Additionally, conducting more targeted market research with a specific focus on test facilities can be a valuable step. By obtaining feedback from the market, including customers and industry stakeholders, organizations can gain valuable insights into evolving industry trends, emerging customer needs, and areas of opportunity. This market research can provide a solid foundation for informed decision-making and strategic planning, enabling test facility providers to adapt their offerings to meet the evolving demands of their target customers effectively.

However, between these challenges of identifying the demand lies a growing opportunity. The true potential of innovation emerges through collaboration, particularly with partners who possess capabilities beyond the organization's scope. The number of organizations and companies embracing this collaborative mindset is on the rise, necessitating facilitators who can enable such innovation and collaboration. Nordic Edge anticipates a notable increase in community-driven focus as underdeveloped testing areas require further development. While acknowledging the presence of excellent national test centers, Nordic Edge recognizes their underutilization and relative obscurity. To address this, they aim to expand the testing perspective, highlighting the possibility of collaborating with non-specialized test arenas to test business ideas. As Nordic Edge looks towards the future, they have strategic plans in place to build upon their Smart City focus while expanding into other sectors as well. Recognizing a growing demand, they aim to establish an innovation cluster specifically dedicated to agricultural technology. This demonstrates the recognition of Nordic Edge's understanding that yielding to market demand is crucial, as it represents the pathway to the most significant opportunities. By responding to the demands of the market, Nordic Edge can position itself strategically to leverage the potential for growth, innovation, and success.

Moreover, the world's growing complexity and emphasis on addressing climate challenges present significant opportunities for innovation test facilities. Copenhagen Solution Lab,

driven by Copenhagen City's ambition to achieve climate neutrality, plays a vital role in implementing solutions developed by organizations like them. However, the interview with Copenhagen Solution Lab highlighted a knowledge gap on the consumer side, emphasizing the need for enhanced information dissemination. As a result, their future focus will center on projects bridging this knowledge gap. The interviewee envisions their ongoing role as a bridge between external knowledge and the implementation of innovative solutions within the city, fostering increased collaboration.

EMEC acknowledges that both the UK Government and the Scottish Government have established clear and ambitious targets for achieving net-zero emissions, promoting green hydrogen, and expanding offshore wind initiatives. To meet these targets, significant scaling up of activities is necessary, and EMEC recognizes its vital role in this process. Describing itself as an innovation catalyst, EMEC understands the importance of remaining relevant in addressing climate change challenges and working towards net-zero goals. They have observed an increasing demand for testing in the offshore wind sector and identified a gap and potential for growth in the tidal sector, prompting their focus on these areas.

4.1.2 Proper infrastructure

EMEC, the physical test center discussed in this thesis, recognizes that the availability of suitable infrastructure for testing is a key factor in ensuring successful operations. Without proper infrastructure, partner organizations are unable to test their products in realistic conditions. Consequently, EMEC places high priority on maintaining and developing their test facilities to meet the increasing demand. They also understand the importance of establishing an efficient supply chain to ensure the effective operation and maintenance of devices deployed at sea. Given EMEC's involvement in the clean energy sector, they have faced various challenges related to the existing infrastructure. As a result, they have invested time and resources in constructing a robust infrastructure capable of effectively meeting the demand.

EMEC acknowledges that they will continue to play a significant role in providing test facilities in the future. Their growth aspirations primarily focus on expanding the tidal site, as it is progressing at a faster pace than waves. They aim to have the capability to test multiple projects simultaneously, as their current capacity allows only one project at a time. This necessitates expanding their test facilities to accommodate customer demands. Additionally, they are exploring the expansion into the offshore wind sector as part of their future.

In the realm of smart cities and clusters, it is crucial for other case organizations to have access to appropriate testing infrastructure. These organizations rely on identifying suitable partners who can provide opportunities for product development, enabling them to contribute to the advancement of smart cities or enhance their own operations. Through collaboration with partners offering necessary resources and expertise, these organizations can drive innovation, develop innovative products, and contribute to the realization of the smart city vision.

4.1.3 The right people with the right competence

One crucial factor emphasized in multiple interviews and publications is the presence of the right people with the right competence. This holds true in the context of managing test facilities and having experts who can support the testing process and follow up the customer's needs. It is vital that the ones who are managing the test facilities understand their own organization and can deal with processes where you find out what the needs are and then translate them into something that you can make the private companies deliver. Moreover, the diversity of backgrounds and skills among employees within the organization is viewed as advantageous, as it enables a broader scope of coverage compared to a homogeneous workforce. Collaboration among five to twenty participants from different organizations and geographical locations can present challenges, making it crucial to have someone adept at managing the inherent complexity.

If we consider the key individuals involved in test facilities, it is essential to recognize the role of facilitators or project managers who possess a holistic view of the project. These individuals should possess accurate knowledge of the project and demonstrate flexibility and understanding of the nature of innovation. Collaboration often involves diverse partners, spanning different countries, time zones, and cultures, making it challenging to maintain cohesion. In the case of Copenhagen Solution Lab and EMEC, they rely on internal facilitators for their projects. It is crucial for these facilitators to have comprehensive information about the project and all collaborating parties. On the other hand, for Nordic Edge, key individuals are often found externally among their cluster members. When these members understand their purpose within the cluster and actively participate, it becomes easier for organizations like Nordic Edge to work with them.

For SIVA, which coordinates its catapult centers rather than directly managing the innovation test centers, they perceive industry experts as key individuals. While these experts may be external to the organization, they typically possess experience and deep insights into the

technologies being developed. SIVA believes that such collaborations are enhanced by leveraging the expertise of these individuals and does not rely on internal facilitators in this role. This approach can be likened to listening to experienced mountaineers when embarking on a mountain trip. Similarly, SIVA considers the knowledge and understanding of the industrial process crucial for successful collaboration at their catapult centers. Having someone who can oversee the entire process from concept to market introduction is vital for companies. SIVA believes they have effectively utilized this approach by enabling their customers to benefit from the competence of the daily operators at the test facilities. This ensures that the relevant expertise is available for using the equipment and methods.

Determining whether it is best for the organization to have internal or external facilitators for projects depends on the specific project at hand. Norwegian Catapult's approach of leveraging local knowledge and ensuring the capacity of those involved in daily operations is a valuable way to utilize test facilities. This approach avoids creating test facilities dedicated to a single purpose with limited future use. In contrast, organizations like EMEC, which focus on a specific area and have sufficient customers in that domain, can benefit from internal facilitators who become experts in their specific test facilities. This unlike to the perspective of a catapult center.

The success factor for working with innovation test facilities can be summarized by highlighting the significance of individual personality rather than specific roles. The emphasis lies on the individuals' qualities and attributes, such as their passion, drive, and ability to bring about change. This implies that the success of test facilities is more about the people who are running them rather than the positions they hold. In addition, a diverse composition of individuals in collaborations can contribute to gaining new perspectives and insights. Diverse backgrounds and viewpoints can enrich the decision-making process and lead to innovative solutions.

4.1.4 Financial support

Financial support is a critical factor in the operation of physical test facilities and smart cities. This importance is evident when examining the impact on physical test facilities like EMEC. With the removal of financial assistance for their customers, the option of utilizing EMEC's testing services became unfeasible, resulting in fewer customers accessing the test facilities. Similarly, for Copenhagen Solution Lab, ongoing support is vital for their survival as a case organization. As a smart city test facility, it is the responsibility of the authorities to cover the associated expenses.

During the interview with EMEC, it was revealed that commercial challenges, rather than technical failures, often lead to project failures. Technical failures are seen as valuable learning opportunities, allowing companies to rectify mistakes and apply the lessons learned in future designs. However, many companies conducting tests at EMEC's sites have struggled to secure the necessary funding. The lack of investment has resulted in the discontinuation of numerous projects, underscoring the importance of a supportive policy and funding environment for innovation. Nevertheless, the challenge lies in convincing potential funders to provide financial support, which requires showcasing success stories to generate their interest and confidence.

The question often arises as to whether a test facility is a necessity or simply a desirable addition. Copenhagen Solution Lab faced this deliberation when authorities encountered constraints on cost reduction opportunities. In the short term, postponing activities like air pollution testing and developing better solutions for city residents may not create an immediate crisis, especially when compared to essential services like waste management in a city like Copenhagen. However, it should be noted that Copenhagen Solution Lab primarily focuses on developing long-term solutions. Implementing effective solutions in a city takes time. When faced with the possibility of discontinuing the Smart City program, Copenhagen Solution Lab successfully shifted the authorities' perspective by highlighting their work and the tangible results it delivered to the city's population. This approach persuaded the authorities to continue their investment and provided a clearer vision of future achievements. It is crucial for authorities to develop strategies and funding models that support long-term innovation projects and acknowledge that success may not be immediately apparent.

Nordic Edge also faces a significant funding challenge. While they currently receive the highest level of funding from Innovation Norway, this support is limited to a five-year period, and they are currently in the third year of that funding cycle. Consequently, Nordic Edge must explore alternative sources of income within the next two years to sustain their current level of activity, as they are not eligible to reapply for another five-year funding cycle.

The approach of authorities towards innovation test facilities holds influence over the investment decisions made by individuals and companies within a region. When the government sets targets or provides revenue support for specific areas, it serves as a signal for people to invest in innovative ventures, encouraging projects to receive funding. Conversely, if the support is withdrawn, it directly impacts the operations of facilities like EMEC. This change in policy environment prompted EMEC to revise its strategy. Previously, they

maintained a level of independence from their clients, who would utilize their test facilities without extensive involvement from EMEC. However, in response to the altered policy landscape, EMEC adopted a more active role by becoming a facilitator between companies, assisting them in securing funding for test activities and aiding in the application process as well. The interviewee from EMEC highlighted that due to the negative shift in the policy environment, many companies that had previously engaged in test activities faced financial difficulties and either went into administration or were absorbed by larger companies that subsequently closed their innovation operations in the field. This outcome was a direct consequence of the inadequate support within the policy framework.

To address the government-related challenges, EMEC implemented two strategies. Firstly, they increased their involvement in lobbying efforts with the government. The interviewee invested time and effort in educating politicians and government representatives about the crucial role of facilities like EMEC in facilitating the commercialization of technologies. They emphasized how these technologies can contribute to achieving ambitious net-zero targets and emphasized the importance of ensuring that those in power possess accurate information and understanding of how innovation aligns with broader goals. EMEC recognized the significance of influencing decision-makers with the right knowledge.

Additionally, when the government withdrew support for marine energy activities, EMEC took a broader approach by expanding their focus beyond wave and tidal energy. They incorporated wider energy systems and green hydrogen into their operations. This allowed EMEC to explore integration opportunities between different energy sources, such as tidal energy, wind energy, and the emerging field of green hydrogen. By diversifying their scope, EMEC aimed to adapt to the changing policy landscape and explore new avenues for innovation and collaboration within the energy sector.

Overall, financial support is crucial for the operation and success of innovation test facilities. It is essential to advocate for supportive policies, highlight success stories, and explore alternative funding sources to sustain and expand the operations of these facilities. Additionally, fostering collaboration between public and private entities and aligning innovation goals with broader societal objectives can help secure ongoing financial support and promote the development of innovative solutions.

4.1.5 Dare to fail

Failure is an integral and indispensable component of the innovation process. Failure is a crucial part of the innovation process, and a necessity. It is through failure that we gain insights into what does not work, enabling organizations to adapt and refine their approaches accordingly. It is essential to acknowledge that failure is not indicative of weakness but rather an opportunity for growth. In the case of organizations managing test facilities, it becomes imperative to embrace the willingness to fail as it paves the way to discovering optimal solutions.

During the interview with Copenhagen Solution Lab, it was highlighted that several of their projects have been discontinued due to their focus on innovation. For innovation to thrive, they emphasize the need to be courageous enough to halt projects that lack potential.

Engaging in innovation collaboration entails inherent risks, as the outcomes are uncertain. The interviewee shared an anecdote where initial discussions with a salesperson painted an ideal picture of a sensor capable of fulfilling all requirements. However, during the implementation phase, it became evident that the sensor fell short of expectations.

Additionally, legal hurdles can arise, such as restrictions on deploying the intended sensor for the project. A specific example of a terminated project involved a sensor designed to detect when a garbage can is full. Unfortunately, these sensors proved to be less dependable than anticipated, as they detached when subjected to forceful opening and closing or became damaged when contaminated with substances like ketchup.

EMEC expressed a similar approach to Copenhagen Solution Lab regarding the termination of non-viable projects. The essence of innovation lies in the quest for effective solutions. To illustrate this, the interviewee shared a project example involving an innovative blade design utilizing a new composite material. The blades were manufactured in Southeast Asia and transported to Scotland for testing in a turbine. However, they proved to be unable to withstand the harsh marine conditions, lasting less than 24 hours. Despite thorough analysis and high expectations, the reality of the test sites exposed the limitations. This experience exemplifies the inherent learning process, where the discovery of problems leads to the discovery of solutions. Interestingly, the interviewee from EMEC noted that many individuals are reluctant to discuss encountered challenges due to the perception of failure. However, they emphasized that failure plays a crucial role in the learning journey, as much of what they have learned stems from these experiences.

In conclusion, daring to fail is an essential aspect of the innovation process and managing test facilities. Organizations like Copenhagen Solution Lab and EMEC demonstrate the importance of being willing to discontinue non-viable projects and learn from failures. Embracing failure as a learning opportunity allows organizations to adapt, refine their approaches, and discover optimal solutions. Openly discussing challenges and failures contributes to a culture of innovation and continuous improvement, driving future success.

4.1.6 Creating a link between the collaborators

Efficient, inclusive, and effective collaboration holds paramount significance in the context of innovation test facilities, which often involve cooperative efforts. The interview emphasizes the importance of collaboration within the Triple-Helix model, including academia, companies, and authorities, to enhance the potential of innovation. A key success criterion highlighted is the consensus among collaborators regarding the shared objective they are collectively striving towards. This alignment allows for optimal resource utilization and provides clarity regarding the desired outcomes to be achieved. Further details regarding collaboration within these organizations will be discussed in the next chapter.

4.1.7 Different perspective, but much of the same view

The chapter emphasizes six key factors for success in test facilities, which the interviews show that hold significance for all organizations involved in this thesis, regardless of their perspective. While it is true that having proper infrastructure for physical test arenas may be more central to physical test arena like EMEC, the other organizations also require access to such infrastructure. For instance, Nordic Edge benefits from the offering of this infrastructure by some of their cluster members. These six success factors are therefore seen as a common understanding of the four case organizations as key success factors for innovation test facilities. While it is acknowledged that additional factors may contribute to the success of innovation test facilities, this thesis specifically highlights these six factors as crucial for their effectiveness.

4.1.8 Summary of the important aspects related to the key success factors of innovation test facilities

In summary, the chapter highlights six key factors critical for success in innovation test facilities:

Demand: Understanding and adapting to evolving customer needs, fostering knowledge-sharing among stakeholders, and conducting targeted market research to stay informed about industry trends and customer needs.

Infrastructure: Maintaining and developing proper infrastructure to meet the increasing demand for testing, ensuring a competitive advantage is maintained.

Competence: Having the right people with the right skills and passion for managing and working with innovation test facilities, enabling effective management, and driving action and change.

Financial Support: Securing adequate funding for the operation of physical test facilities and smart cities, as a lack of funding can lead to project discontinuation and challenges in securing necessary investments.

Embracing Failure: Recognizing that failure is an integral part of the innovation testing process, providing valuable insights for adaptation and refinement of approaches. Failure should be viewed as an opportunity for growth rather than a weakness.

Collaboration: Creating strong links and collaboration among stakeholders within the triple-helix model, which includes academia, companies, and government, to foster innovation and achieve shared objectives.

These key factors that have been highlighted as central are not surprising given the previously existing literature on the topic. These key factors underscore the importance of understanding customer needs, maintaining infrastructure, nurturing competent individuals, securing financial support, embracing failure as a learning opportunity, and promoting effective collaboration for success in innovation test facilities.

4.2 Collaboration

In the first chapter of this thesis, the importance of collaboration and establishing effective links among collaborative partners is highlighted as one of the key factors for success within a region. This following chapter will delve deeper into exploring efficient strategies and approaches to foster strong collaboration between stakeholders.

This chapter will begin by addressing the general key findings on collaboration from the interviews conducted in this thesis. Subsequently, the discussion will shift towards external collaboration, encompassing various stakeholders such as government, universities, supply chain companies and the EU. Following that, the internal dynamics within Smart City initiatives, innovation clusters, and catapult centers will be explored. Finally, a summary of the findings will be provided.

4.2.1 Collaboration within innovation test facilities

It turns out that some of the same general points for ensuring successful collaboration with innovation test facilities that are highlighted in the literature are also highlighted in the interviews in connection with this thesis. This sub chapter will refer to some of the general findings on collaboration.

It became evident that reaching a mutual agreement on project goals and desired outcomes is essential for successful collaboration. This ensures that the collaboration starts off on a productive note, and all parties have a clear understanding of their roles and responsibilities. Regardless of the partner or the size of the collaboration, this alignment is crucial for effective collaboration.

The interviews conducted for this thesis echo the key points highlighted in the literature regarding successful collaboration. It is evident that establishing a shared understanding and agreement on project goals and desired outcomes is vital for fruitful collaboration. This initial alignment sets the stage for productive collaboration, enabling all parties involved, regardless of their size or role, to have a clear understanding of their responsibilities and contribute effectively to the collaboration.

It is also brought out in the interview that it can be an advantage to enter collaboration as early as possible in the process. By assuming a leadership role from the beginning, it becomes possible to guide the project in the right direction, potentially reducing the duration of the initial phase and expediting the implementation of the solution. SIVA with their catapult centers, for example, employs workshops to assess the project's status and determine the next

steps. In this process, the customer presents a preliminary product or method concept for testing, seeking the catapults assistance in further development using their test facilities. The objective is to identify the underlying challenges and root problems associated with the proposed test, with a focus on market viability and commercial success. Typically, five or six main problems are identified, leading to the question of whether the catapult centers can contribute to addressing these key issues. If the answer is affirmative, the collaboration begins.

In a collaborative workshop, industrial experts from various companies join forces with the customer to explore solutions for the identified challenges. For example, in the interview with EMEC it was told that they discovered that replacing a steel structure with aluminum can significantly reduce weight, making the product more viable. The optimal timing for such a workshop, and whether the initial product sketch should be refined or left open-ended, is subject to discussion. It may not be productive for the idea originator to invest time in detailed solution development. Instead, individuals with core competence in design and production should focus on their expertise. For instance, within the healthcare sector, specialists who have experience with a particular issue may struggle to develop a product prototype. In such cases, it is more advantageous to delegate the task to someone with the required expertise to ensure effective progress.

Regarding the protection and patenting of their work, EMEC has a confident stance. They believe that the need for offshore demonstration facilities worldwide outweighs the need for strict protection, as their goal is to address the global challenge of climate change and foster a global market for clean energy technologies. While they are the only accredited laboratory for testing wave and tidal technologies, they view others operating in a similar space not as competitors but as collaborators. However, it is important to acknowledge that solutions developed in their region in Scotland may not necessarily be applicable in all countries due to climate differences. Nevertheless, they are open to sharing their solutions if they can be adapted and used elsewhere. This is a way of ensuring that the information on the innovation that is taking place passes on.

The four case organizations of this thesis share a strong consensus on the use of effective collaboration to foster increased innovation in their region. They engage with various agencies that apply to all four organizations, as they actively collaborate both external and internal.

4.2.2 The importance of collaboration with external stakeholders

As previously discussed in this thesis, the triple helix model, encompassing the public, private, and academic sectors, is commonly involved in innovation endeavors of a region. External stakeholders typically approach case organizations with ideas or products to be tested, necessitating internal and external collaborations to meet customer requirements. This sub chapter includes representation from various entities, including government, universities, supply chain companies and the EU.

Government

When it comes to developing collaborations across the triple helix model, it is crucial to consider the role of the government in the region. EMEC, for instance, operates at the intersection of these sectors, aiming to foster cooperation among them. While EMEC is not strictly a public sector entity, it was built using public funds and operates in the public interest. It is not solely a private sector organization either, as it must be self-sufficient. Brexit and the UK's departure from the European Union have presented challenges for EMEC, located in Scotland. They faced the loss of previous long-term European collaborations because of the restrictions from the government. This highlights the influence of government policies on collaboration opportunities, both at the regional, national, and international levels. Despite the limitations imposed by government decisions, organizations like EMEC must accept the reality of losing potential partners and had to adapt by seeking alternative collaborations.

In the specific context of Scotland and Norway, where the government changes every four years, decision-making processes related to innovation can be impacted. Government officials may prioritize initiating and completing projects during their tenure to enhance their own credibility, rather than considering the potential benefits for future administrations. This poses a challenge when working with long-term perspectives in innovation, as rushing results solely for the sake of showcasing progress may not be the most effective approach. Sometimes, it is more advantageous to delay certain outcomes until later stages of the process.

Nordic Edge, for example, recognizes the importance of lobbying with the government in their region to foster a culture of innovation. They have observed a positive shift in the public sector's willingness to embrace innovation when they are well-informed about its potential. However, there still exists a significant gap between the public sector's understanding and the potential benefits of innovation. Bridging this gap requires ongoing efforts to inform and

educate government officials about the value of innovation and its long-term impact on society and the economy. In order to facilitate the continued development of the region, it is crucial for the government to possess the necessary knowledge and understanding of the requirements for progress.

In summary, government involvement and policies play a significant role in shaping collaboration opportunities in a region within the triple helix model. While challenges arise from government restrictions and cyclic decision-making, organizations must adapt and seek alternative collaborations. Fostering a culture of innovation requires ongoing efforts to inform and educate government officials about the potential benefits of innovation for society, ensuring long-term strategies that transcend political cycles.

Universities

It is mentioned in one of the interviews that collaboration with universities offers a valuable opportunity to engage in idea development from the earliest stages and provide support throughout the implementation process. Nevertheless, it is surprising that the interviewees in these four case organizations do not mention university more than they do in these interviews. Copenhagen Solution Lab has used them to collect data which the university helped to analyze afterwards. In this way, Copenhagen Solution Lab gets help in obtaining the necessary information, while at the same time including the University in an important job of mapping the city of which they themselves are a part. In this way, ownership and focus on both the environment and the development of Copenhagen as a smart city may be increased.

Nevertheless, you can read on the website of EMEC that they collaborate with universities, and for example EMEC in 2011 had a collaboration on strategic alliances formed with funky ocean research center for energy with Canada and the Ocean University of China and in 2012 had a collaboration with Scapa Flow where Nottingham University deployed its Energy Bag at the smaller wave test site (Centre T. E., u.d.). This is so common for them that they did not think to bring it up in interviews when asked about collaboration, or that the questions did not directly open for them to mention this.

By involving the university in regional innovation collaborations, there is an increase in ownership of development from the university's perspective. This can have a positive impact on the younger generation who attend the university, as they gain awareness of the region's challenges and actively contribute to solving them. This mutually beneficial arrangement

benefits both the long-term growth of the region and the immediate progress of the development projects, as the university can contribute specific expertise and insights.

Supply Chain Companies

Collaboration with supply chain companies holds significant importance for EMEC, as it enables them to take risks, experiment with new products and methods, and create a ripple effect of benefits for individuals and the region. One notable example is the partnership with local vessel companies, previously engaged in fishing and fish farming, which has diversified their operations and generated new opportunities for economic growth. By highlighting the capabilities of local small vessels on EMEC's test sites, the organization has eliminated the need to rely on large vessels from elsewhere in Europe. This not only strengthens the local supply chain but also demonstrates the economic viability and sustainability of utilizing smaller vessels.

As another concrete example, the interviewee from EMEC shared a successful collaboration with one of their longstanding clients involved in tidal energy development. The company initially began by testing small-scale and then progressed to full-scale 250-kilowatt turbines. Over time, they advanced through various technology readiness levels, reaching the milestone of deploying the world's largest tidal turbine, currently undergoing testing at EMEC's tidal test site. Through their progress, the company successfully attracted investments from industrial partners, marking a remarkable journey from humble beginnings to commercial deployments.

EMEC aimed to generate positive economic impact in their region which historically was facing limited opportunities for employment and development. EMEC's presence in Orkney has not only benefited the local community but also the entire country due to the extensive supply chain associated with their activities. A notable example of EMEC's economic impact is their £36 million investment in innovative test infrastructure two decades ago. An economic impact assessment conducted in 2019 revealed that this initial investment generated an impressive £306 million for the UK economy. This demonstrates the substantial economic benefits derived from EMEC's operations.

Another inspiring example comes from Copenhagen Solution Lab, which focused on addressing air pollution in Copenhagen. Recognizing the potential of Google's cars equipped with street image-capturing cameras, they collaborated with Google to develop a specialized sensor capable of measuring air pollution levels. By integrating this sensor into Google's cars, they efficiently collected comprehensive air pollution data throughout the city. This

innovative approach surpassed conventional practices, and despite the complexities involved, the project succeeded with support from two local universities, which contributed expertise in sensor technology and data analysis. The collaboration exemplified the power of interdisciplinary cooperation and technological advancements in combating critical issues like air pollution.

During interviews, it was emphasized that developing something new through innovation and test facilities involves a series of interconnected challenges. The key is to approach these challenges in a flow, where one step leads to the next. Success is achieved when a product is efficiently produced and accepted in the market. To navigate these processes smoothly, it is beneficial to work with experienced partners who have gone through similar processes multiple times before. Collaborating with such partners saves time and ensures better transitions between steps.

Given that developments at test facilities often require the development of related products within a supply chain, it is essential to connect test facilities within the same industries. For instance, in the context of the green shift, connecting test facilities for shipping and offshore wind becomes crucial. The interdependency between different players in the supply chain is a focal point that deserves attention. Similarly, when developing a new product in an industry like green shipping, it is important to connect with test facilities that specialize in automated production. Failing to establish these connections runs the risk of achieving success in Norway but losing out on value creation outside the country's borders. Therefore, this link between test facilities and the supply chain companies is vital from a national perspective.

In summary, collaboration with supply chain companies allows EMEC to take risks, diversify operations, and create economic opportunities. Approaching challenges in a flow and collaborating with experienced partners facilitates smoother transitions and increases the likelihood of success. Connecting test facilities within industries and establishing links with the broader supply chain ensures value creation within the country and drives national progress in areas like the green shift.

EU funded projects

When EU-funded projects are undertaken in Norway, the availability of full-scale test facilities becomes crucial in ensuring the successful execution of significant work packages within these larger research and development initiatives. Collaborations with the EU involve multiple stakeholders, including equipment suppliers and research institutions from both

national and international backgrounds. Most EU-funded projects in Norway focus on driving the green shift, making innovation test facilities essential for advancing sustainable development.

In an interview with SIVA, it is emphasized that when Norway participates in EU-funded projects, conducting testing within Norway holds significant importance. This strategic approach is motivated by the potential for Norway, along with its major businesses, to achieve breakthroughs that contribute to further Norwegian value creation. This is because the opportunities for other organizations that support this breakthrough increase with this, and the breakthrough requires support activities. By conducting testing and measurements in Norway, involving Norwegian companies in the development process, the opportunity for achieving 50% Norwegian value creation. This not only enhances the chances of technological breakthroughs but also stimulates the growth of new Norwegian companies. In contrast, if the test facilities were in another country, the maximum achievable Norwegian value creation would be limited to 20%, significantly reducing the potential. This serves as a compelling national incentive for Norway to enhance its value creation capabilities within the business sector.

Collaboration with the EU in this manner can be viewed as a powerful catalyst for generating new opportunities and collaborations. For instance, the development of the world's first full-scale multi-spring engine for the maritime sector, housed in Norway's Energy House at Stord, demonstrates the immense potential for value creation through collaboration and test facility utilization. The ongoing testing of different combinations of hydrogen and conventional diesel batteries in this engine exemplifies the opportunities for innovation and progress enabled by test facilities.

In large-scale projects, effective cooperation between clusters, catapult centers, and leading companies is vital. SIVA's role is to facilitate how consortia in Norway connect with each other and initiate collaborations. Here, Norway enjoys an advantage as a small country, where networking and communication are streamlined. The interview highlights that in Norway, one can reach the desired individual with just two phone calls—a clear advantage compared to larger countries where access to key individuals may be more challenging due to a larger population.

In conclusion, the availability of full-scale test facilities in Norway plays a pivotal role in maximizing the benefits of EU-funded projects. By conducting testing within the country,

Norway increases the potential for significant Norwegian content, stimulates the growth of new businesses, and enhances value creation. Moreover, collaboration with the EU serves as a catalyst for generating new opportunities, fostering innovation, and strengthening cooperation among various stakeholders. The advantage of Norway's close-knit community and ease of communication further facilitates successful collaborations in the pursuit of shared objectives.

4.2.3 Internal collaboration

Effective internal collaboration is crucial when testing new innovative ideas and products. In this thesis, the concept of internal collaboration is not limited to within an individual organization but is also considered in the context of the specific type of test facility being examined. As a Smart City initiative, collaborating with other entities involved in smart city development proves advantageous, as it helps avoid duplicating efforts and promotes knowledge sharing. In innovation clusters, seamless cooperation among all members is essential for the cluster to thrive; otherwise, there would be little benefit in being part of the cluster. Similarly, for catapult centers, the consortia must work collectively to meet the demands and requirements of the market. This necessitates a significant level of cooperation among the members. This sub-chapter will examine the three components—smart city initiatives, innovation clusters, and catapult centers—with a specific emphasis on their internal collaboration, as viewed within the context of this thesis.

Smart City Initiatives

The interviewee from Copenhagen Solution Lab highlighted their involvement as a founding partner of the Nordic Smart City Network, a collaboration among 19 Nordic cities aimed at developing smart cities and solutions together. A key aspect of this collaboration is ensuring a good flow of information, so the cities can learn from each other experiences and avoid duplicating efforts. They have physical meetings four times a year to discuss ongoing projects and share insights. Additionally, they maintain a website where they upload relevant information accessible to all member cities. The shared values and ways of life among the Nordic countries make it easier to develop solutions that can benefit multiple cities within the network. The Nordic Smart City Network serves as a prime example for cities coming together to share knowledge, resources, and insights to collectively develop innovative solutions. This shared foundation allows member cities to identify familiar challenges and collectively work towards addressing them, leading to more impactful and sustainable smart city initiatives.

In line with the literature on regional development and smart cities, collaborating with cities that share similar prerequisites is also in the interview regarded as advantageous. As demonstrated in the example mentioned earlier, the Nordic collaboration, it becomes apparent that working with cities that possess similar characteristics can facilitate smoother cooperation. While it is possible for certain smart city initiatives to be implemented in cities with dissimilar attributes, additional effort may be required to tailor the measures accordingly. Therefore, smart cities are encouraged to seek collaborations with other cities that exhibit comparable characteristics such as size and population. By doing so, they can capitalize on the shared experiences and challenges, leading to more effective and efficient smart city initiatives

In the interview, the representative from Copenhagen Solution Lab mentioned their focus on climate solutions and their plans to collaborate more closely with companies in a more organized manner. They have also formed a partnership with a newly developed area outside of Copenhagen, which is expected to accommodate 50,000 residents and workers. As part of this partnership, Copenhagen Solution Lab collects data from the various companies and organizations operating in the area. They utilize this information, gathered from sources such as transport companies, Mastercard, and social media, to drive their smart city development efforts and create solutions that can be applied not only in the specific area but also in other cities.

In conclusion, the collaboration within the Nordic Smart City Network serves as a platform for knowledge exchange and collective problem-solving among cities in the Nordic. This collaboration, built upon shared values and experiences, enables cities to leverage their collective expertise in developing innovative solutions. The example of Copenhagen Solution Lab highlights their commitment to climate solutions and their strategic partnership with a new area outside Copenhagen. Through data-driven approaches, they aim to create impactful solutions that can positively influence urban environments. The importance of collaboration among smart cities with similarities is underscored, as it allows for the establishment of networks that foster mutual learning and the development of effective urban solutions.

Innovation clusters

When working with innovation test facilities in a cluster program, it is important to follow up and have good cooperation with the members of the cluster. Nordic Edge has its own follow-up program for the cluster members, and they are in regular dialogue with as many as possible

as often as they can. A major review is carried out once a year, where it is revealed whether they have grown and created capital, and whether they have export plans and active collaborations. For Nordic Edge as the leader of this cluster, it is an advantage to have a good insight into what the various members think about development and further work, to prepare for what is to come. The implementation of a comprehensive follow-up program, including regular dialogues and an annual review allows Nordic Edge to gain insights into how the member of the cluster are working together.

Nordic Edge, as a cluster of member organizations, has witnessed the financial growth and success of several of its members through their collaborative efforts. This achievement reflects positively on Nordic Edge itself, as it measures its progress by the accomplishments of its cluster members. In 2022 alone, the cluster companies collectively generated approximately 420 million in funding. These funds directly contribute to increase the innovation capacity within the cluster. The ability of cluster members to secure capital for their innovation and commercialization endeavors is perceived as a significant success for Nordic Edge. This accomplishment highlights the effectiveness of the cluster's collaborative approach and underscores the potential for further growth and positive outcomes in the future. Being part of a cluster offers inherent advantages, particularly when there is effective collaboration among its members. This highlights the importance of maintaining a robust flow of information and ensuring that all cluster participants have access to relevant and timely information.

Overall, Nordic Edge's collaborative approach, follow-up programs, and vertical focus on Smart City initiatives have proven instrumental in driving innovation, securing funding, and creating a supportive environment for cluster members. Their commitment to long-term planning and facilitation of innovation positions Nordic Edge as a key player in enabling the growth and success of the cluster.

Catapult Centers

Catapult centers, which in this thesis is represented by SIVA, announce competitions to be one of their catapult centers, which they call catapults. When catapults are chosen, this is done with a long-term perspective. Since a lot of time and money is invested in this work, it is foolish to stop when it is half developed. Nevertheless, SIVA with the catapult centers is not afraid to stop cooperation with catapults if things are not working well. This highlights the

commitment to maintaining high standards and ensuring that the chosen centers are effectively contributing to innovation and development.

The approach of selecting established consortia based on their ability to fulfill existing demands is widely regarded as an effective strategy for providing test facilities in a region. By bringing together consortium members who have already demonstrated a foundation for collaboration through their joint application for catapult center status, the stage is set for productive collaboration. Once selected as a catapult center, the key lies in maintaining a smooth flow of information and conducting necessary follow-ups to ensure continued success.

To monitor the progress and effectiveness of the Catapult centers, a three-year evaluation cycle is implemented. External companies, SIVA itself, and the Catapult center conduct assessments to evaluate the center's performance and determine the way forward. This comprehensive assessment process allows for addressing the status of the center and identifying areas for improvement or adjustments. By conducting these evaluations, SIVA ensures that the Catapult centers remain on track and align with the desired outcomes. At the time of writing this thesis, SIVA had established five Catapult centers and eight additional nodes, which are considered supplementary centers to the larger Catapult centers. The vision from the outset was to establish seven to nine Catapult centers covering various areas. This vision reflects the intention to have a diverse range of specialized centers that cater to different sectors or industries, maximizing the impact and scope of the Catapult initiative.

Overall, the selection process, evaluation cycles, and vision for future expansion underscore the strategic approach taken by SIVA in managing Catapult centers. By ensuring a strict selection process, conducting regular evaluations, and envisioning a comprehensive network of centers, SIVA aims to maximize the impact and effectiveness of the catapult initiative in driving innovation and industrial development.

4.2.4 Summary of the findings on collaboration

Within this subchapter, the primary findings derived from the analysis regarding collaboration are summarized, with specific attention given to the various collaborations emphasized throughout the study. When collaborating with both external and internal stakeholders, it is important to accommodate the needs and requirements of those involved in the collaboration.

Government: The involvement of the government and its policies in a region significantly influence collaboration opportunities within the triple helix model. Organizations must adapt and seek alternative collaborations despite challenges posed by government restrictions and

cyclic decision-making. It is crucial to inform and educate the government about the benefits of innovation, fostering a culture of innovation that transcends political cycles. By adopting these collaborative approaches with the government, the region can unlock its full potential for development.

Universities: Collaboration with universities is valuable for idea development and support throughout the implementation process and at the same time increasing involvement in the region by including young people at university in the collaboration. While some interviewees mention university collaborations, it is surprising that they are not emphasized more.

Copenhagen Solution Lab, for example, utilizes universities for data collection and analysis, enhancing their mapping efforts and promoting ownership and focus on the environment and the development of Copenhagen as a smart city.

Supply chain companies: Collaboration with supply chain companies benefits EMEC as a physical test arena by enabling risk-taking, diversification, and economic opportunities.

Working with experienced partners and establishing connections within industries and the broader supply chain facilitates smoother transitions and increases the likelihood of success. This collaboration drives national progress and value creation in the region.

EU: The availability of full-scale test facilities in Norway is crucial for the success of EU-funded projects, particularly those focused on driving the green shift and sustainable development. Conducting testing within Norway enhances the potential for significant value creation and stimulating the growth of new businesses as an outgrowth of the EU project. This endeavor will significantly contribute to the region's development in the desired direction.

Smart cities: Collaboration within the Nordic Smart City Network serves as a platform for knowledge exchange and collective problem-solving among Nordic cities, which are regions that share common values. Shared values and experiences allow cities to leverage their collective expertise in developing innovative solutions.

Innovation Clusters: Nordic Edge's collaborative approach, follow-up programs, and vertical focus on Smart City initiatives are instrumental in driving innovation, securing funding, and creating a supportive environment for cluster members. Their long-term planning and facilitation of innovation position them as key players in enabling cluster growth and success.

Catapult centers: SIVAs strategic approach to managing Catapult centers, including the selection process, evaluation cycles, and vision for future expansion, aims to maximize the

impact and effectiveness of the initiative in driving innovation and industrial development. The approach of operating innovation test facilities as the catapult centers is considered highly advantageous due to their ability to bring together consortia of established companies. This ensures that a wealth of experience is already available, making it a favorable method for driving innovation.

5 Conclusion

This thesis focused on test facilities, examining the research methodology, relevant theoretical concepts, and case organizations. It presented the findings and insights derived from interviews conducted as part of the research.

The findings of this thesis are divided into two parts, corresponding to the two aspects of the research question. The first part focused on the key factors associated with successful test facilities. The results from the interviews demonstrated that a key factor for success is a demand for the services offered by the organization operating the test facilities. In the case of physical test facilities, it is crucial to have well-established infrastructure that can effectively cater to the needs of customers during testing processes. For smart cities and clusters, access to quality infrastructure for testing ideas and products, including through collaborative partnerships, is essential. Having the right people as facilitators within the test facilities is emphasized as a key factor in achieving success, as their presence can enhance the efficiency of the testing process. Sufficient financial support for the projects being tested is also considered crucial, and a willingness to embrace mistakes is highlighted as important. Rather than viewing failure as a weakness, it should be seen as an opportunity for growth. Furthermore, creating strong connections and fostering collaboration among the various stakeholders involved in the test facilities is mentioned as another success factor. Establishing meaningful links between collaborators can contribute to the overall success of the test facility initiatives.

The second aspect addressed in this thesis pertains to how effective collaboration can act as a catalyst to enhance innovation capabilities and drive societal progress within a region. The findings highlighted several key points. Firstly, it is crucial to ensure that the government is well-informed about the benefits of innovation test centers, and organizations must take responsibility for disseminating this information effectively. Collaborating with supply chain companies can be highly advantageous, as it enables the entire innovative solution to be developed within the region, thereby fostering further value creation.

In the case of smart cities, success lies in sharing information and establishing collaborations with like-minded entities, ensuring that these partnerships are effectively maintained. For innovation clusters, implementing effective follow-up methods for cluster members and facilitating productive dialogues are essential. Adopting a long-term perspective is important, as the results of collaborative efforts may not be immediately evident. Drawing inspiration

from existing consortia, such as the catapult centers, where testing already takes place, can prove advantageous.

Moreover, for Norway to advance nationally, it is crucial to prioritize cooperation with major actors such as the European Union (EU). This cooperation fosters increased value creation and stimulates business growth, particularly if Norway becomes a preferred location for test facilities.

5.1 Limitations and future research directions

Despite the valuable insights and findings presented in this master thesis, there are certain limitations that should be acknowledged. Firstly, the research focused on a specific set of case organizations and their perspectives on collaboration and innovation test facilities. While these cases provide valuable insights, they may not fully represent the diversity and complexity of all organizations involved in similar endeavors. Therefore, the generalizability of the findings to a broader context should be interpreted with caution.

Secondly, the research primarily relied on qualitative data obtained through interviews and case studies. While this approach allowed for in-depth exploration and understanding of the subject matter, it may limit the generalizability of the findings. Future research employing quantitative methods or larger sample sizes could provide a more comprehensive and statistically robust analysis.

Building upon the insights and limitations identified in this master thesis, several avenues for future research can be suggested. These directions aim to further expand our understanding of collaboration and the utilization of innovation test facilities for societal development. Future Research Directions could be:

- Impact Assessment with focus on more economics: Investigate the long-term impact of collaboration and innovation test facilities on regional development. Assess the economic, social, and environmental outcomes of successful collaborations and explore ways to measure their effectiveness in contributing to societal goals.
- Policy and Governance: Explore the role of policy frameworks and governance structures in facilitating collaboration and leveraging innovation test facilities. Analyze how regional, national, and international policies can be designed to support effective collaboration and encourage the growth of innovation ecosystems.

By addressing these future research directions, we can further advance the understanding and practices surrounding collaboration and the effective utilization of innovation test facilities for societal development, fostering a more sustainable and prosperous future.

6. References

- BALLON, P. P. (2005). *Test and experimentation platforms for broadband innovations: Examining European Practice*. Brussel: Interdisciplinary institute for Broadband Technology (IBBT).
- Bank, E. C. (2017, 06 27). *Why does innovation lead to growth?* Retrieved from European Central bank: <https://www.ecb.europa.eu/ecb/educational/explainers/tell-me-more/html/growth.en.html>
- Bhasin, H. (2021, july 07). *Boundary Spanning*. Retrieved from Marketing 91: <https://www.marketing91.com/boundary-spanning/>
- Boyles, M. (2022, 03 08). *INNOVATION IN BUSINESS: WHAT IT IS & WHY IT'S SO IMPORTANT*. Retrieved from Harvard Business School Online: <https://online.hbs.edu/blog/post/importance-of-innovation-in-business>
- Cai Yuzhuo, N. R. (2018). *Economic specialization and diversification at the country and regional level: introducing a conceptual framework to study innovation policy logics*. Retrieved from University of Agder: <https://www.tandfonline.com/doi/epdf/10.1080/09654313.2018.1529142?needAccess=true&role=button>
- Center, E. M. (2023, may 09). *EMEC the European Marine Centre Ltd*. Retrieved from 20 years of EMEC instigates UK wide economic impact: <https://www.emec.org.uk/20-years-of-emec-instigates-uk-wide-economic-impact/>
- Centre, T. E. (n.d.). *About Us*. Retrieved from The European Marine Energy Centre: <https://www.emec.org.uk/about-us/>
- Centre, T. E. (n.d.). *Facilities*. Retrieved from The European Marine Energy Centre : <https://www.emec.org.uk/facilities/>
- Centre, T. E. (n.d.). *Our history*. Retrieved from The European Marine Energy Centre: <https://www.emec.org.uk/about-us/emec-history/>
- Comission, E. (n.d.). *Smart Cities*. Retrieved from European Comission: https://commission.europa.eu/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en
- Comission, E. (n.d.). *Testing and Experimentation Facilities (TEFs): Questions and answers*. Retrieved from European Comission: <https://digital-strategy.ec.europa.eu/en/faqs/testing-and-experimentation-facilities-tefs-questions-and-answers>
- Dalland, O. (2017). *Metode og Oppgaveskriving*. Gyldendal Forlag.
- Dictionary, C. (n.d.). *Consortium*. Retrieved from Cambridge Dictionary: <https://dictionary.cambridge.org/dictionary/english/consortium>
- Dictionary, C. (n.d.). *Testing facility*. Retrieved from Collins Dictionary: <https://www.collinsdictionary.com/dictionary/english/testing-facility>
- Donald, L. (n.d.). *Om Oppdragene*. Retrieved from Innovasjon Norge : <https://www.innovasjon norge.no/no/om/oppdrag-og-resultater/om-oppdragene/>
- Edge, N. (n.d.). *About*. Retrieved from Nordic Edge: <https://nordicedge.org/about/>

- Edge, N. (n.d.). *Advancing a smarter and greener Tomorrow*. Retrieved from Nordic Edge: <https://nordicedge.org/>
- Evans, J. a. (2014). Give me a laboratory and i will lower your carbon footprint. *International Journal of Urban and Regional Research*.
- HAMDOUCH, A. (2008). *CONCEPTUALIZING INNOVATION CLUSTERS*. Washington, USA: SSRN.
- Hans Hellsmark, J. F. (2016, 06). *The role of pilot and demonstration plants in technology development and innovation policy*. Retrieved from Research Policy: https://www.researchgate.net/publication/303774487_The_role_of_pilot_and_demonstration_plants_in_technology_development_and_innovation_policy
- Hans Schaffers, N. K. (2012). *Smart Cities as innovation Ecosystems sustained by the future internet*. HAL Archives.
- høgskolerådet, U. o. (n.d.). *Innovasjon*. Retrieved from Universitets- og høgskolerådet: <https://www.uhr.no/temasider/innovasjon/>
- Institute, T. W. (n.d.). *What is a smart city*. Retrieved from The Welding institute: <https://www.twi-global.com/technical-knowledge/faqs/what-is-a-smart-city>
- Jacques Bughin, E. W. (2019, 10 16). *Reviving innovation in Europe*. Retrieved from McKinsey & Company: <https://www.mckinsey.com/featured-insights/innovation-and-growth/reviving-innovation-in-europe>
- Kessler, B. (n.d.). *The Kinds of Collaboration That Lead to Successful Innovation*. Retrieved from Insead Knowledge: <https://knowledge.insead.edu/leadership-organisations/kinds-collaboration-lead-successful-innovation>
- KPI.org. (n.d.). *KPI.org*. Retrieved from What is Key performance indicator?: <https://www.kpi.org/kpi-basics/>
- Kylliainen, J. (2019, April 26). *Viima*. Retrieved from The Importance of Innovation – What Does it Mean for Businesses and our Society?: <https://www.viima.com/blog/importance-of-innovation>
- Lab, C. S. (n.d.). *Cases*. Retrieved from Copenhagen Solution Lab: <https://cphsolutionslab.dk/cases>
- Lab, C. S. (n.d.). *Who are we?* Retrieved from Copenhagen Solution Lab: <https://cphsolutionslab.dk/>
- Leo A. Grünfeld, A. M. (2016). *Infrastruktur for testing, pilotering, visualisering og simulering*. Norge: Menon Economics.
- Mark Dodgson, D. M. (2014). *The Oxford Handbook of Innovation Management*. New York: Oxford universite Press.
- Ministers, N. C. (2018). *Nordic Test and demonstration facilites*. Nordic Council of Ministers.
- Mohammes Saad, G. Z. (2011). *Theory and Practice of the Triple Helix System in Developing Countries*. New York: Routledge.
- More, R. (2011, July). *What is success in innovation?* Retrieved from Ivy business Journal: <https://iveybusinessjournal.com/publication/what-is-success-in-innovation/>

- Norge, I. (n.d.). *Disse gründermiljøene får ekstra midler*. Retrieved from Innovasjon Norge: <https://www.innovasjon norge.no/no/om/nyheter/2021/styrket-tilbud-til-okosystem-for-opstartselskaper/>
- Norge, I. (n.d.). *Kort om oss / About us*. Retrieved from Innovasjon norge: <https://www.innovasjon norge.no/no/om/kort-om-oss/>
- North, J. (n.d.). *Collaborative innovation*. Retrieved from The Big Bang Partnership: <https://bigbangpartnership.co.uk/collaborative-innovation/>
- Norway, U. N. (2023, 01 31). *Industri, innovasjon og infrastruktur*. Retrieved from <https://www.fn.no/om-fn/fns-baerekraftsmaal/industri-innovasjon-og-infrastruktur>
- Norway, U. N. (2023, 02 02). *Samarbeid for å nå målene*. Retrieved from FN-Sambandet: <https://www.fn.no/om-fn/fns-baerekraftsmaal/samarbeid-for-aa-naa-maalene>
- NTNU. (n.d.). *nyskaping*. Retrieved from NTNU: <https://www.ntnu.no/nyskaping>
- Ove Granstrand, M. H. (2020). *Innovation Ecosystems: A conceptual review and a new definition*.
- Phil, R. (2021, nov 07). *Store Norske Leksikon*. Retrieved from København: <https://snl.no/K%C3%B8benhavn>
- Presidente, G. a. (2022, 05 06). *Disrupting science: How remote collaboration impacts innovation*. Retrieved from The Centre for Economic Policy Research: <https://cepr.org/voxeu/columns/disrupting-science-how-remote-collaboration-impacts-innovation>
- Regjeringen. (2020). *Innovasjon i offentlig sektor*. Retrieved from Regjeringen: <https://www.regjeringen.no/no/tema/statlig-forvaltning/forvaltningsutvikling/innovasjon-i-offentlig-sektor/id2610542/>
- Research, A. i.-B. (n.d.). *intersectoral collaboration*. Retrieved from Arctic institute of Community-Based Research: <https://www.aicbr.ca/capacity-building>
- Rodriguez, R. C. (2011). *Innovation and Regional Growth in the European Union*. Springer. Retrieved from https://books.google.no/books?hl=no&lr=&id=QyWk00FDH7oC&oi=fnd&pg=PR3&dq=why+innovation+is+important+for+regional+development&ots=Ni9pchvmEv&sig=5SVGCbyqrR3Op iYmCr84u5JXtPQ&redir_esc=y#v=onepage&q=why%20innovation%20is%20important%20for%20regional%20devel
- School, H. I. (2013). *Boundary Spanning: A Crucial Business Skill*. Retrieved from Hult International Business School: <https://www.hult.edu/blog/boundary-spanning-a-crucial-business-skill/>
- Services, I. o. (n.d.). *Innovation Clusters*. Retrieved from Institute of Management Services: <https://www.ims-productivity.com/page.cfm/content/Innovation-Clusters/>
- SIVA. (n.d.). *Norsk Katapult*. Retrieved from Fakta om Norsk Katapult / Facts about Norwegian catapult: <https://norskkatapult.wpenginepowered.com/wp-content/uploads/2021/04/norskkatapult-fakta-260321.pdf>
- SIVA. (n.d.). *Om norsk katapult / About Norwegian Catapult*. Retrieved from SIVA: <https://norskkatapult.no/om-norsk-katapult/>

7. Appendix

7.1 Interview guide

This is the interview guide used as a base for the conducted interviews. Some adjustments to the questions were made based on the various interviewees

1. Introduction

- Which organization are you working for?
- Can you talk about your role in your organization?
- How long have you been working in your organization and in this role?
- Can you tell a bit about what is your organizations function?
- What is your organizations short and long term aims?

2. Success factors for innovation test centers

- What do you see as the key factors for accomplishing your organizations aims with focus on innovation?
 - o What are the critical resources, capabilities and competencies required for you to accomplish it?
- Have your organization faced some special challenges or obstacles, and how did you address these?
- How do you measure how far you are from reaching your organizations goals, and what metrics are used?
- Can you talk about an innovation project which accomplished its goals that has been implemented through your organization and collaboration, and some factors about this project?

3. Collaboration

- Can you give an example of a partnership that has increased the innovation capacity of your organization or a project of yours?
 - o Who are/were the key people and in which roles for this collaboration? Do they work in your organization or also in others?
- Do you have had any collaborations that have been terminated before it reached it goals or that did not continue further projects. If there were, why do you think it did not continue?
- Can you outline the key players in your ecosystem with focus on collaboration?

- What do you see as the key points in terms of collaboration to achieve common goals for innovation?

4. Future plans

- What are your organizations plans for the future, in terms of innovation test centers and other initiatives?
 - Do you see any challenges or opportunities that your organization foresees in the upcoming years?
 - How do you plan to address these challenges and take advantage of the opportunities?
 - How do you see the role of innovation test centers evolving in the future?
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- Do you have any final thoughts or recommendations that you would like to share?